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ABSTRACT

Presented is an instructor's manual for a learning session centered on the methodology and feasibility of land treatment of municipal wastewater. A supplementary slide-tape program is available. These materials are components of the Working for Clean Water Project, which is intended to educate advisory groups who are interested in improving decision making in water quality planning. (WB)

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ED209482

Working for Clean Water

An Information Program for Advisory committees

Land Treatment

Instructor Guide

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION

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SE 035 557

Land Treatment

Land treatment of municipal wastwater must be considered as an alternative treatment method under facilities planning. Land treatment puts wastewater to work to grow crops and get more mileage from water and energy resources while reducing pollution. Communities finding land treatment to be feasible and cost-effective can get 85 percent federal funding for their projects, including the purchase or leasing of land. Conventional wastewater treatment facilities are eligible for only 75 percent federal funding.

Upon completion of this presentation, the participant should be able to:

- Assist in planning efforts to assure land treatment is considered fairly
- Help to identify potential land treatment sites
- Help to identify community attitudes towards acceptance of land treatment
- Understand the relative cost-effectiveness of land treatment
- Understand the role of land treatment in solving today's water pollution problems
- Recognize the relative advantages of land treatment as compared to conventional wastewater treatment
- Define land application methods and recognize their potential use.

Required Materials

☐ Set of slides plus cassette tape for the audiovisual presentation, "Land Treatment of Municipal Wastewater, A New Look at an Old Idea"

☐ Slide projector, screen, and related equipment

☐ Set of flip charts plus easel or set of transparencies and overhead projector for guided discussion

Continued on next page

☐ Good, clear topographical map of the local area

☐ Copy of handbook, "Land Treatment," for each participant

☐ Copy of "Evaluation Checklist for Land Treatment Alternatives," for each participant. (A copy can be found in the Appendix.)

Important Notes

1. Before this presentation the instructor should:

   a. Prepare introductory comments using A History of Land Application as a Treatment Alternative.

   b. Review the Evaluation Checklist for Land Treatment Alternatives for use in the guided discussion. The checklist highlights various considerations that must be evaluated for land application of wastewater. Some of the items in the checklist may be deleted depending on the local situation.

2. Group discussion of the items in the Evaluation Checklist will have to be tightly controlled if the time schedule is to be followed. Items of local interest should be emphasized.

3. Discussion of case studies may be included if time permits. Also a case study could be developed to use as a guide for discussing the items in the Evaluation Checklist.

Suggested Activities

Introductory Comments	5 minutes
A/V Presentation	20 minutes
Guided Discussion	25-35 minutes
Closing Questions and Answers	10 minutes
TOTAL TIME	60-70 minutes

Introductory Comments (5 minutes)

1. Land treatment represents the most nearly perfect answer to water pollution control problems because it emphasizes recycle and utilization of the effluent.

2. Land treatment is not "new technology" but in fact predates other wastewater treatment technology.

Use data from A History of Land Application as a Treatment Alternative to illustrate this point.

3. Go over the key questions. Ask the participants if they have other questions they wish to add concerning land treatment.

A/V Presentation (20 minutes)

1. Show the slide/tape program "Land Treatment of Municipal Wastewater, A New Look at an Old Idea." It provides excellent coverage of the topic including some case history information.

A/V script is in the Appendix in case of equipment failure.

2. Advise the participants to jot down any comments or questions for later discussion.

3. Answer any questions and discuss any comments the participants may have from the slide/tape program.

Guided Discussion (25-35 minutes)

1. Hand out copies of the Evaluation Checklist.

Briefly go over the scope and objectives of the local project.

This is Part A of the checklist. Use a map of the area to define the local project boundaries and problems.

This is Part B.

2. State the local wastewater characteristics with respect to the existing treatment and effluent disposal facilities.

This is Part C.

3. Review site selection factors. Solicit lots of input from the advisory group members, since they should be experts on the local climate, topography, soil type, etc.

Use topographical map of local area.

4. Evaluate potential sites in the project area.

This is Part D of the checklist.

5. Consider appropriate methods of land application based on the project objectives and characteristics of the selected potential sites.

This is Part E.

6. Discuss the impact on the environment, including public health, social, and economic aspects, for each land treatment alternative.

This is Part F.

7. Consider various ways to implement the project.

Discuss the role of the advisory group in project implementation.

Closing Questions and Answers (10 minutes)

1. Use the key questions in the handbook to promote discussion. Use this time to evaluate the participants' understanding of the material.

2. Local area considerations should be reinforced during this discussion.

3. If possible, have a state or local regulatory agency official present to help with questions regarding the local area.

Selected Resources

Alternative Waste Management Techniques for Best Practicable Waste Treatment. EPA-430/9-75-013. MCD-13. Washington, DC: U.S. Environmental Protection Agency, October 1975. 71 pp.

This document is intended to provide information on practicable techniques by which publicly-owned treatment works can restore and maintain the integrity of the nation's waters. The publication identifies the currently known techniques including land treatment, summarizes the technology, and provides an extensive bibliography. This publication is free and can be ordered from: General Services Administration (8FSS) Centralized Mailing List Services, Bldg. 41, Denver Federal Center, Denver, CO 80225. Indicate the MCD number and title of publication.

Guide to Clean Water Act Amendments, EPA No. OPA 129/8. Washington, DC: U.S. Government Printing Office, November 1978.

This publication contains many of the provisions of PL 92-500 (The Federal Water Pollution Control Act of 1972) and PL 95-217 (The Clean Water Act of 1977). It can be obtained from the U.S. Government Printing Office, Washington, DC 20402.

Hartman, Willis J., Jr. An Evaluation of Land Treatment of Municipal Wastewater and Physical Siting of Facility Installations. Washington, DC: U.S. Department of the Army. May 16, 1975. 65 pp.

This reported study and evaluation is directed toward providing some guidance to those who might select land treatment as an alternative process. Particular emphasis is placed on siting facilities in more populated areas. The report costs $8.00 and can be obtained from NTIS, 5285 Port Royal Rd., Springfield, VA 22161. The order number is ADA016118.

Jewell, William J. and Seabrook, Belford L. A History of Land Application as a Treatment Alternative. EPA-430/9-79-012. MCD-40. Washington, DC: U.S. Environmental Protection Agency, April 1979. 83 pp.

This publication presents a complete history of land treatment technology including discussions of policy and a consideration of the future of land treatment. This publication is free and can be obtained from: General Services Administration (8FSS) Centralized Mailing List Services, Bldg. 41, Denver Federal Center, Denver, CO 80225. Indicate the MCD number and title of publication.

Land Treatment of Municipal Wastewater Effluents. Three Volumes. Cincinnati, OH: Technology Transfer Municipal Seminar Publications, 1979.

These publications cover the various methods of wastewater treatment techniques on land including slow-rate irrigation, rapid infiltration, and overland flow. It is a good set of reference manuals suitable for persons with limited knowledge but interest in land treatment. They are available free from CERI, Technology Transfer, U.S. Environmental Protection Agency, Cincinnati, OH 45268. Specify order number 4010.

Pounds, Charles E., Crites, Ronald W. and Smith, Robert G. Technical Report Costs-Effective Comparison of Land Application and Advanced Wastewater Treatment. EPA-430/9-75-016. MCD-17. Washington, DC: U.S. Environmental Protection Agency, November 1975. 25 pp.

This report is intended to be used for general cost comparisons of advanced wastewater treatment and land application systems. The curves shown in the figures are presented only for comparative purposes and should not be used to estimate costs of specific alternatives in facilities plans. This publication is free and can be obtained from: General Services Administration (8FSS) Centralized Mailing List Services, Bldg. 41, Denver Federal Center, Denver, CO 90225. Indicate the MCD number and title of publication.

Survey of Facilities Using Land Application of Wastewater. EPA-430/9-73-006. UNA-03.0. Washington, DC: U.S. Environmental Protection Agency, July 1973. 377 pp.

This report presents the results of a field survey of 100 facilities where land application of domestic or industrial wastewater effluents were applied to the land. Ninety-nine tables and the collected data are presented along with photographs of representative facilities used to illustrate land application practices. This publication is free and can be ordered from: General Services Administration (8FSS) Centralized Mailing List Services, Bldg. 41, Denver Federal Center, Denver, CO 80225. Indicate the UNA number and title of publication.

Walker, John. Wastewater: Is Muskegon County's Solution, Your Solution? EPA-905/2-76-004. MCD-34. Chicago, IL: U.S. Environmental Protection Agency, Region V, September 1976. 50 pp.

This case study describes vividly and interestingly the rationale, implementation, and operation of Muskegon's system. The report is available free from: General Services Administration (8FSS), Centralized Mailing List Services, Bldg. 41, Denver, CO 80225. Indicate the MCD number and title of publication.

Assistance may be provided by the Land Treatment Coordinator in the Water Division of each EPA regional office.

Appendix

A. Handout for use by instructor in the guided discussion.

1. Evaluation Checklist for Land Treatment Alternative

B. Copy of the script for the slide/tape program, "Land Treatment of Municipal Wastewater, A New Look At An Old Idea."

Evaluation Checklist for Land Treatment Alternatives

A. Project Objectives

Consider the objectives and goals relevant to water quality protection or groundwater aquifer, the need for increasing existing water resources, and any other desired effects. ☐

B. Evaluation of Wastewater Characteristics

1. Existing treatment (description, adequacy for intended project) ☐

2. Existing effluent disposal facilities (description, consideration of water rights) ☐

C. Evaluation of Potential Sites

1. General description

a. Location (distance from collection area or treatment plant, elevation relative to collection area) ☐

b. Compatibility with overall land-use plan (current use, proposed future use, zoning and adjacent land use, proximity to current and planned developed areas, is there room for future expansion) ☐

c. Proximity to surface water ☐

d. Number and size of available land parcels ☐

2. Environmental characteristics

a. Climate (precipitation analysis and seasonal distribution, storm intensities, temperature with seasonal variations, evapotranspiration, wind velocities and direction) ☐

b. Topography (ground slope, description of adjacent land, erosion potential, flood potential, extent of clearing and field preparation necessary) ☐

c. Soil characteristics (type and description, infiltration and percolation potential, soil profile, evaluation by soil specialists) ☐

d. Geologic formations (type, evaluation by geologist, depth of formations, earthquake potential) ☐

e. Groundwater (depth to groundwater, groundwater flow, depth and extent of any perched water, quality compared to requirements, current and planned use, location of existing onsite and adjacent wells) ☐

f. Receiving water (type, current use, existing quality, water rights) ☐

3. Methods of land acquisition or control (purchase, lease, purchase and lease back to farmer, contract with users) ☐

D. Consideration of Land Application Alternatives

1. Irrigation

a. Purpose (increase crop yields, maximize effluent application, irrigate landscape) ☐

b. Application techniques (spraying, ridge and furrow, flooding) ☐

2. Infiltration-percolation

a. Purpose (groundwater recharge, pumped withdrawal or underdrains, interception by surface water) ☐

b. Application techniques (spreading, spraying) ☐

3. Overland flow (spray-runoff)

a. Purpose (discharge to surface waters, reuse of collected runoffs) ☐

b. Application techniques (spraying, flooding) ☐

4. Combinations of treatment techniques (combinations of land application techniques at the same or different sites, combinations of land application with in-plant treatment and receiving water discharge) ☐

5. Compatibility with site characteristics ☐

E. Environmental Assessment

1. Environmental impact

a. On soil and vegetation ☐

b. On groundwater (quality, levels, flow direction) ☐

c. On surface water (quality, flow) ☐

d. On animal and insect life ☐

e. On air quality ☐

f. On local climate ☐

2. Public health effects (groundwater quality, insects and rodents, runoff from site, aerosols, contamination of crops) ☐

3. Social impact (relocation of residents, effects on greenbelts, open space, recreational activities, community growth) ☐

4. Economic impact (on overall local economy, tax considerations on land, conservation of resources and energy) ☐

F. Implementation Program

1. Public information program

a. Approaches to public presentation (local officials, public hearings, mass media, local residents and land owners, communication with special-interest groups) ☐

b. Public opinion (engineer's response, review of problem areas) ☐

2. Legal considerations ☐

3. Reevaluation of ability to implement project ☐

4. Implementation schedule (construction schedule, long-range management plan) ☐

LAND TREATMENT OF MUNICIPAL WASTEWATER
A New Look At An Old Idea

Slide Description		Narrative
1.	EPA Logo	EPA Logo
2.	Words: Land Treatment of Municipal Wastewater A New Look At An Old Idea	Land Treatment of Municipal Wastewater* A New Look at An Old Idea
3.	Picture: Fresco of Greek farmer	Wastewater was applied to the land in ancient Greece.
4.	Picture: German farmland	Germans have used it to irrigate their farms since the 16th century.
5.	Picture: Farmland being spray irrigated	It's use spread to the United States in the late 19th century with the first projects being developed for irrigation purposes.
6.	Picture: Farmlands	Groundwater recharge using wastewater effluent was started early in the 20th century in semi-arid regions of the southwest.
7.	Picture: Traveling boom spray irrigation	Today this old idea for using wastewater is getting a new look.
8.	Picture: Center pivot spray boom	Land treatment of wastewaters from community ---
9.	Picture: Land treatment of industrial waste	and industrial sources is practiced successfully and extensively in the United States and in countries throughout the world.
10.	Picture: Overland flow	With a rising awareness of worldwide shortages of food, water and energy, people are coming to think of wastewater as what it really is -- a resource -- something to be recycled and re-used even while being cleansed.
11.	Picture: Wastewater irrigation of crops	Land application is putting wastewater to work to grow crops and get more mileage from water and energy resources while reducing pollution.

*Produced for the EPA Region VI by TEC Films, Inc. Modified by Penn State University.

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12.	Picture:	Containment pond	It captures wastewater nutrients as fertilizer, minimizes surface stream pollution, restores groundwater supplies, and uses less energy than required by conventional treatment systems.
13.	Drawing:	Water percolation through soil	By simple definition, land application means putting wastewater onto the land rather than discharging it into surface streams.
14.	Picture:	Wastewater settling basins	Usually the process involves pre-application treatment --
15.	Picture:	Irrigation by overland flow	followed by application of the wastewater to land areas selected for their capacity to cleanse the water and filter out remaining nutrients.
16.	Picture:	Control panel of a wastewater treatment plant	Thus land application of wastewater becomes an alternative method of treatment to meet water quality standards without going to the full and usually more expensive route of conventional wastewater treatment.
17.	Words:	The Clean Water Act showing changes made by the 1977 amendments	The Clean Water Act of 1977 requires communities seeking federal funds for wastewater treatment systems to consider land application as an alternative treatment method.
18.	Drawing:	Federal funding differences between conventional and land treatment	Communities finding it feasible and cost-effective can get 85 percent funding for their projects including purchase or lease of land, compared to 75 percent for conventional treatment.
19.	Picture:	Meeting of local government	Land application requires careful planning, thorough cost evaluation, effective operation, and routine monitoring.
20.	Picture:	Pretreatment of wastewater	Land treatment achieves water quality goals with simple and low-cost pre-application treatment of the wastewater.
21.	Words:	"We must press vigorously for this method of reclaiming and recycling municipal wastewater"	In a major policy statement, the U.S. Environmental Protection Agency said: "We must press vigorously for this method of reclaiming and recycling municipal wastewater."

22.	Picture:	Wastewater discharging into a stream	Rigorous standards discouraging the discharge of wastewater into waterways have contributed to the current interest in land application.
23.	Picture:	Treatment plant	Land treatment policy stems from three major elements. Much wastewater today requires the removal of nutrients to protect surface streams.
24.	Picture:	Fertilizer machinery	Fertilizer shortages, as well as costs, accent the need for recovery of these nutrients from wastewater.
25.	Picture:	Farmer examining crops	Operating systems and research studies prove the capacity of soils and plants to purify waters and reuse the nutrients from wastewater.
26.	Drawing:	Region 6 and 7 map	In the nine states comprising EPA Regions 6 and 7, there are more than 300 land application systems with many more in prospect. The bi-regional area embraces a giant portion of middle America -- Arkansas, Louisiana, New Mexico, Oklahoma and Texas in Region 6; Missouri, Kansas, Iowa and Nebraska in Region 7.
27.	Drawing:	Map of U.S.	In the United States-at-large, there are more than 700 land treatment systems at present with more coming on line.
28.	Words:	Irrigation, Infiltration, Overland Flow	Land application techniques or methods may be grouped into three categories: Irrigation Rapid Infiltration and Overland Flow
29.	Drawing:	Irrigation illustration	Irrigation is application of wastewater to the land by surface or spray to grow crops. It is the most common land treatment technique.
30.	Picture:	Spray irrigation	This picture shows irrigation by spray.
31.	Drawing:	Infiltration illustration	Rapid Infiltration is an approach by which large volumes of wastewater are applied to the land, infiltrate the soil surface, percolate through the soil pores, and recharge the groundwater.
32.	Picture:	Infiltration basin	The method is shown in this rapid infiltration basin.

33. Drawing: Overland flow illustration		Overland Flow is a treatment method by which wastewater is applied to grassy slopes and allowed to run off through the vegetation.
34. Picture: Spray application		It may involve spray or surface applicatio
35. Picture: Surface application		Each of these treatment methods has its advantages and limitations, depending upon its application to a given situation.
36. Words: Land availability, climate, soil types, topography, geology, and groundwater characteristics		Factors which influence selection of a land treatment system include land availability, climate, soil types, topography, geology, and groundwater characteristics.
37. Picture: Conventional treatment for urban areas		Because land treatment involves land and land involves cost, land application systems may be too expensive for some communities, especially acreage near a large city.
38. Drawing: Buffer zone illustration		High land costs favor conventional treatment systems, especially where large buffer areas are required around the application areas.
39. Picture: Farmland		However, land treatment sites are not limited to municipal ownership. Sometimes the public agency and the farmer have combined resources to create a system.
40. Picture: Holding pond		It is not necessary for communities using land treatment systems to own and operate farms. A city may supply the pre-treated wastewater to a holding pond. Through agreements with the city, farmers then can withdraw the water and apply it to their farms.
41. Picture: Monitoring tests		The city must maintain sufficient operational and monitoring control to make sure the control objectives are met. Beyond that, however, the enterprising farmer with suitable land is indeed in a good negotiating position to have his land irrigated out of the city's waste treatment budget with a profit bonus from the water and nutrients

42.	Picture: Two holding ponds	The city of Abilene, Taxas owns about 2200 acres of farmland and leases about 1,500 acres to a single farmer who irrigates crops with wastewater from the city's secondary treatment facility.
43.	Picture: Cropland	In addition, six other farmers in the area use the effluent to irrigate about 1800 acres of cropland, mostly maize and cotton. About half of the city's treated wastewater is discharged to surface streams.
44.	Picture: Pipeline in cornfield	The system is working well with mutual benefits to the city and the farming community, says Dwayne Hargesheimer, Director of Water Utilities.
45.	Words: "Land application facilities reflect a general improvement of the environment rather than impairment.	The American Public Works Association concluded from a survey of some 100 operating systems that "land application facilities reflect a general improvement of the environment rather than impairment." The same survey concluded that land application systems revealed no specific health hazards.
46.	Picture: Water testing kit	On the basis of all available knowledge, health hazards from land application of wastewater are minimal, although continuing monitoring and research are essential.
47.	Picture: Cropland	During the dry summer of 1972, farmer L. E. Kohl began pumping wastewater from the City of Vandalia, Missouri, and using it to irrigate his crops. That year his corn out-produced his dry-land corn by 65 bushels per acre.
48.	Picture: Irrigation pump	In 1974 Kohl was irrigating 240 acres of corn which yielded 122 bushels per acre. The Vandalia lagoon system was not large enough to hold the water he needed, so last year he built a larger reservoir to hold wastewater which previously had been discharged into surface streams during the fall and winter.
49.	Picture: Wheat field	Today, with added capacity of the lagoon system, Kohl says his farm raises about 400 acres of corn, 100 acres of wheat, and 500 acres of soybean per year, and feeds 1800 head of hogs.

50.	Picture:	Holding pond	Kohl's land application project has been monitored routinely for health hazards, with no adverse effects. There has been no appreciable buildup of chemicals or metals, and no undesirable odors.
51.	Picture:	Long shot farmland	Roswell, New Mexico -- a city of 45,000 -- has been operating a land application system since 1944. It provides wastewater used by nine farmers who irrigate between 700 and 1,000 acres of corn, alfalfa and cotton.
52.	Picture:	Pipe discharging into storage reservoir	This picture shows the storage reservoir with irrigated fields in the background.
53.	Picture:	Irrigation ditch	The ditch carries effluent from the storage reservoir to the fields.
54.	Picture:	Land treatment in small community	The small farming community of Humphrey, Nebraska, discharges about 100,000 gallons of wastewater effluent per day to a storage lagoon.
55.	Picture:	Spray application	There it is delivered to farmer Melvin Bender, who irrigates 100 acres of corn and soybeans -- applying about 13 inches of water annually through a center pivot spray system.
56.	Picture:	Medium shot spray application	The arrangement has proved mutually beneficial to both the town and the farmer, producing between 100 and 125 bushels of corn per acre as compared to about 50 bushels per acre produced on non-irrigated land in the same area.
57.	Picture:	Fertilizer containers	The removal of nitrogen and phosphorus by conventional treatment methods requires chemicals as well as energy and drives the cost of the treatment upward.
58.	Picture:	Medium shot of bales in field	Land treatment not only conserves this energy, but it puts the nutrients to work for higher crop yields with savings in fertilizer costs.
59.	Drawing:	Energy use bar graph	Studies show it takes much more energy for a conventional wastewater plant to produce the same quality of reclaimed water yielded by the land application process.

60.	Picture: Spray irrigation site with rotating boom	Since 1975 Muskegon County, Michigan has been using land application of wastewater stored in aerated lagoons.
61.	Picture: Field of corn	The system operating from April to November in 1975 treated 27 million gallons per day on 5400 acres of land.
62.	Picture: Piles of bagged fertilizer	The reuse of nitrogen, phosphorus and potassium from the corn irrigation in 1975 amounted to $110,000 in fertilizer value.
63.	Words: 800,000 tons nitrogen, 700,000 tons phosphorus, 4,700 tons potassium	It has been estimated that the domestic waste effluent discharged to surface streams on a national scale contains 800,000 tons of nitrogen, 700,000 tons of phosphorous, and 4,700 tons of potassium per year. This is about 10 to 15 percent of the national fertilizer consumption of these valuable nutrients.
64.	Picture: Close shot corn cob	As an alternative means of wastewater treatment and disposal, land application has been found too successful and too economical to ignore without careful consideration.
65.	Picture: Golf course	Disease germs exist -- both in land treatment and conventional treatment -- but there has been no evidence of disease outbreaks or high health risks, even though wastewater is sometimes applied to golf courses and public parks as well as cropland.
66.	Picture: Small town	Making land treatment systems safe is just like making any community service safe -- buildings, airplanes, trains, highways, utilities, and the like. You have to follow the rules which may vary from project to project.
67.	Picture: Irrigation field with cows in background	Land treatment involves the use of plants and the soil to remove contaminants from wastewaters. It is capable of achieving removal levels that compare to the best available wastewater treatment technologies.

68.	Drawing: Groundwater recharge illustration	Wastewater utilization through irrigation provides excellent pollution control performance. Experience at Penn State University and other groundwater recharge sites shows that the water returned to the groundwater reservoir was suitable as a drinking water source.
69.	Picture: Spray irrigation site in the woods in the winter	The "Living Filter" experiment applies secondary treated wastewater to crop grass and forestland twelve months per year.
70.	Picture: Land treatment design manual	A manual titled "Land Treatment of Municipal Wastewater", prepared jointly by the Environmental Protection Agency, the Army Corps of Engineers, and the Department of Agriculture contains information compiled from an exhaustive research of land treatment systems.
71.	Words: The recovery and beneficial use of wastewater ...	In the Manual's own words: "The recovery and beneficial use of wastewater and its nutrient sources through crop production, as well as wastewater treatment and reclamation, allow land treatment systems to accomplish far more than conventional treatment and discharge alternatives. The utilization of land treatment systems has the potential of saving billions of dollars."
72.	Picture: Advisory Group	Citizen advisors can help assure that land treatment receives its deserved consideration. You can help pick suitable sites, encourage farmers to use land treatment and
73.	Words: Help pick suitable sites, Encourage farmers to use land treatment, Point out local problems	point out local problems which your consultant may have trouble identifying. Facility plans in which land treatment alternatives are eliminated with only cursory coverage will be rejected as not fulfilling EPA requirements. A facility plan should not be approved until coverage of the land treatment alternatives satisfies published guidelines.
74.	"Thank You" slide	
75.	EPA Logo	
76.	Credit Slide	
77.	Credit Slide	